C6 cont.

sufficiently fast to deform through the desired deformation range within the scanning period.

Claim 23 has been amended as follows:

C7

23. (Amended) The scanning module of claim 21 wherein the MEMS membrane has a resonant frequency having a period that is an integral multiple of the scanning period.

Claim 27 has been amended as follows:

Sub D1

C8

27. ~~(Twice~~ Amended) A scanning apparatus, comprising:

a primary mirror that moves through a predetermined scan path at a selected scan rate having a scanning period; ~~and~~

a resonant reflector aligned to the scanning mirror and being of a type that moves resonantly through ~~a~~ movement path at a resonant frequency, wherein the scan period is an integral multiple of the resonant frequency wherein the resonant reflector is a microelectromechanical (MEMS) membrane and wherein the movement path includes deformati~~on of the membrane~~.

Claim 29 has been amended as follows:

C9

29. (Amended) The apparatus of claim 28 wherein the primary mirror is a microelectromechanical (MEMS) device.

REMARKS

This amendment responds to the Office Action dated April 10, 2002. In the Office Action, the Examiner objected to the drawings under 37 CFR 1.83(a). Applicants

will submit formal figures under separate cover to the Drawing Review Branch of the U.S. Patent & Trademark Office. A copy is enclosed with this amendment for the Examiner's convenience.

Claims 3, 5-8, 10-25, and 27-29 remain in this application. Claims 4 and 9 have been canceled. Claims 6, 7, 10, 13, 17, 21, 23, 27 and 29 have been amended.

In the Office Action, the Examiner objected to claims 7, 13, 17, and 21 for an informality. Each of these claims has been amended accordingly. A corresponding change has been made to claims 27 and 29. Also, claim 23 has been amended to correct a minor grammatical error. Dependent claim 6 has also been amended. Dependent claim 4 and independent claim 9 are also canceled hereby. Claim 10 has been amended to become an independent claim, incorporating the limitations of canceled claim 9.

The Examiner rejected claims 6 and 21 under 35 U.S.C 112, as containing "subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the invention." In making this reference, the Examiner refers to "MEMS membrane aligned to the MEMS scanning mirror." Applicants submit that this aspect of the claim is adequately described and supported in the specification. In particular, at p. 29, third paragraph, a corrective element may be an aberration compensation membrane and this may be the deformable membrane. As also described at p. 29, the membrane can be actuated with a single electrode. The deformable membrane can be fabricated using MEMS technology, and can be varied on a rapid timescale under electronic control to perform the correction function, as noted at p. 28. Alignment of the membrane with the MEMS scanning mirror is described in some detail with reference to Figure 53 at p. 37. Thus, the application provides ample description of this aspect.

With respect to claim 6, the Examiner also notes "the broadly describe[d] voltage adjusting means for inducing a voltage rise or drop do not support the claim invention." Applicants first note that claim 6 does not recite a "means for inducing a voltage rise or a voltage drop." Instead, claim 6 recites that the deformable membrane is "responsive to the control signal to deform to produce the corresponding correction." Finally, the Examiner refers to the correction function shown at p. 11, lines 23-24 in reference to a deformable membrane. However, as recited at p. 28, "the deformable mirror 180 ... operates as a dynamic aberration compensation element.... For this type of dynamic correction, the deformable mirror 180 can change its shape rapidly." The description of some types of aberration that may be corrected for by the deformable mirror is presented at various locations in the specification, including pages 29-32.

With respect to claim 21, the Examiner inquires regarding "How the membrane deform range response time within a scanning period [sic]." As noted at p. 28, "The deformable mirror 180 can change its shape rapidly, typically at twice the line scan frequency, on the order of 40kHz. . . The controlled deformable membrane shape can be varied on a rapid timescale under electronic control to perform the correction function in this embodiment." Additionally, a variety of exemplary control approaches are described in some of the references incorporated into the application by reference.

The Examiner has rejected claims 3-6 and 8 under 35 USC 103(a) as being unpatentable over Nishiberi in view of Perkins. Applicants first note that the Perkins patent relates to a phase front compensator for a telescope or radiation antenna. The Perkins reference describes a large area membrane having a variety of electrodes displaced about the membrane to provide localized distortion of the membrane. Thus, the Perkins reference relates primarily to corrections of phase front across a broad area.

This is very different in concept and application from a deformable membrane that corrects phase front of a scanning beam system according to "the predicted deviation of the redirected light beam from the desired light beam at respective locations in a selected scan pattern." As recited in claim 6, the deformable membrane varies in

deformation according to the predicted, nonideal scanning variation. In fact, the "large area" deflection of the Perkins reference is completely antithetical to a "micro"electromechanical system as recited in claim 7.

While applicants submit that unamended claim 6 was distinguishable over the cited references, applicants have further amended claim 6 to more clearly and distinctly claim the subject matter. In particular, claim 6 has been amended to include reference to a periodic scan pattern having a plurality of scan lines with a period and to recite that the correction occurs within one of the scan lines.

Applicants further submit that the combination of Nishiberi with Perkins would not be obvious and that the references fail to suggest their combination. In fact, because the Perkins reference relates to a highly stabilized system such as an antenna or a telescope while the Nishiberi system relates to a multiple mirror scanning system, the teachings are antithetical. For example, Nishiberi describes oscillation throughout the specification with a mirror mounted to a shaft. On the other hand, the Perkins reference refers to large-scale, relatively nonmoving systems. (See, for example, column five, ll. 1-17, describing struts and a support structure as "an essential aspect.") Applicants submit therefore that the cited references would not be obvious to combine and in fact teach away from such a combination, rather than suggesting.

Dependent claims 3-5 depend from claim 6, and are therefore also distinguished over the cited references. Additionally, claim 5 adds that the deflector is "a single deflector mounted for a biaxial rotation." This aspect is neither taught nor suggested by the cited references. While the Examiner has highlighted the aspect of biaxial scanning, the Examiner has not identified this aspect in Figure 2. In fact, elements 3a and 4a are independent elements each having its own mirror. Consequently, this figure teaches away from the element of "a single deflector."

Dependent claim 7 adds to claim 6 that the deformable membrane is a MEMS device. The Examiner has rejected this claim based upon the previously cited

combinations and the addition of admitted prior art relating to a MEMS mirror. However, claim 7 recites that the "deformable membrane" is a MEMS device. Moreover, the inclusion of a deformable membrane within a system to correct for a predicted deviation is neither taught nor suggested by the cited references alone or in combination.

Dependent claim 8 adds to claim 6 that the "deflector includes a position detector" and that the "electrical control circuit. . . is responsive to the electrical signal to produce the control signal." Thus, the deflector includes a position detector, the electronic control circuit responds to the position detector, and the deformable membrane deforms according to this response. Applicants submit that this combination is neither taught nor suggested by the cited references.

Now-independent claim 10 has been rejected in view of the combination of Nishiberi, Perkins, Balasubramanian, and Gal. Applicants submit that the combination of these four references is impermissible hindsight, and that the references lack suggestions for the combination. Moreover, even in combination, these references fail to teach the recited elements. As noted above, none of these references teaches a deformable membrane that deforms according to a predicted deviation in a scanning system.

The Examiner has rejected independent claim 11 and dependent claim 15 as being obvious in view of Hardy. Applicants submit that the Hardy reference fails to teach or suggest the present invention. In fact, Hardy specifically notes that the intention of his invention is to correct for "random wavefront tilts and phase shifts produced by atmospheric turbulence." Thus, the Hardy reference relates to a system that does not include a scanner having "an expected wavefront distortion of the beam at each of the scanning positions." Moreover, the Hardy reference does not include "a wavefront corrector positioned in the beam path... having a response time sufficiently fast to produce the respective offsetting wavefront distortion for each of the respective scanning positions." Instead, the cited reference relates to a system that measures atmospheric distortions and builds up a correction for a stabilized system. This is very different from a scanning system having a wavefront corrector with a sufficiently fast response time.

The Examiner has rejected claims 12-14 has obvious over Hardy in view of Perkins. Applicants note initially that each of these references is not related to a scanning system and thus their teachings are not applicable. Moreover, even in combination, these references do not teach a deformable membrane having a response time sufficiently fast to correct for wavefront distortions corresponding to scanning positions of a scanner. Accordingly, these references do not teach or suggest the recited combination.

The Examiner has rejected claims 16, 19, and 20 as being obvious over Nishiberi. Applicants submit that the cited reference does not teach "an active optical element... operative to predistort the beam of light in a periodic manner." Moreover, the cited reference does not teach predistortion "corresponding to orientation of the scanning mirror." Additionally, claims 19 and 20 add a passive optical element that is a lens. Thus, these claims add that the system includes a passive optical element in addition to the scanning mirror and active optical element, and that the passive optical element receives the redirected beam. Applicants submit that the cited reference does not teach this aspect.

The Examiner has also rejected claims 17 and 18 over Nishiberi in view of admitted prior art. Applicants submit first that the combination does not teach the previously recited combination of elements, as noted above. Also, the cited references do not teach a combination including a "MEMS device" with a deformable membrane that is "operative to pre-distort the beam of light in a periodic manner corresponding to the orientation of the scanning mirror."

The Examiner has rejected claims 21 and 22 over the combination of Nishiberi and Perkins. Applicants note that claim 21 recites a combination of two MEMS elements: "a MEMS scanning mirror that moves to a predetermined scanning path... having a scanning period;" and "a MEMS membrane... deformable... through a desired deformation range within the scanning period." Applicants submit that the cited references do not teach either of these elements or their use in combination.

Moreover, claim 22 recites that the MEMS scanning mirror is mounted for biaxial movement. Neither of the cited references teaches a scanning mirror that moves biaxially. In fact, the combination of two scanning mirrors implies that the mirrors of Nishiberi are limited to a single axis.

The Examiner has rejected claim 23 in view of the combination of Nishiberi, Perkins, and Darrow. Applicants submit that the cited combination of references does not teach the recited combination of elements. First, as noted previously, the cited references do not teach the combination of MEMS elements. Moreover, none of the other references teaches "a MEMS device having a resonant frequency that is an integral multiple of the scanning frequency." Applicants can find no reference to such a device in the Darrow reference.

Claims 24-25 add to claim 21 some specifics regarding the deformation range of the MEMS membrane. Applicants submit that the cited references do not teach such a MEMS membrane and do not teach this aspect of deformation of the MEMS membrane.

Applicants submit that the currently presented claims are distinguishable over the cited references and are thus allowable. The Examiner is invited to contact Mr. Casey T. Tegreene at (425) 415-6621 with any issues that may advance prosecution of the application on the merits.

Please charge any additional fees required to Deposit Account No. 500284.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned

"Versions with markings to show changes made."

Respectfully submitted,

Clarence T. Tegreene, et al.

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Registration No. 37,951

Enclosures:

Postcard
Check
Certificate of Mailing by Express Mail
Transmittal and Fee Calculation Cover Sheet (+ copy)
Petition for Extension of Time (+ 2 copies)
Copies of 36 Sheets of Drawings (Figs. 1-54D)

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Appl. No. 09/400,350

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the claims:

Please cancel claim 4.

~~4. The optical scanning system of claim 3 wherein the predicted deviation includes an angular deviation from an ideal scan path, and wherein the controllable optical element includes a beam deflector that produces an angular shift in the received beam that offsets the predicted deviation.~~

Claim 6 has been amended as follows:

6. (Amended) An optical scanning system for a scanning beam imager or display, for a scanning beam imager or display, comprising:

an input port positioned to accept an input light beam;

at least one deflector aligned to receive the input light beam from the input port and oriented to redirect the received light beam through a selected periodic scan pattern having a plurality of scan lines within a period , the deflector being of a type that produces a predicted deviation of the redirected light beam from a desired light beam at respective locations in the selected scan pattern;

an electrical control circuit operative to produce a control signal corresponding to the selected scan pattern; and

a controllable optical element positioned to receive either of the input light beam or the redirected light beam and having an input terminal for receiving the control signal, the optical element being responsive to the control signal to produce a

corresponding correction that offsets the predicted deviation, ~~The optical scanning system of claim 2~~ wherein the controllable optical element includes a deformable membrane responsive to the control signal to deform within a selected one of the scan lines to produce the corresponding correction.

Claim 7 has been amended as follows:

7. (Amended) The optical scanning system of claim 6 wherein the deformable membrane is a microelectromechanical (MEMS) device.

Please cancel claim 9.

~~9. (Amended) An optical scanning system, comprising:~~

~~an input port positioned to accept an input light beam;~~

~~at least one deflector aligned to receive the input light beam from the input port and oriented to redirect the received light beam through a selected scan pattern, the deflector being of a type that produces a predicted deviation of the redirected light beam from a desired light beam at respective locations in the selected scan pattern;~~

~~an electrical control circuit operative to produce a control signal corresponding to the selected scan pattern; and~~

~~a controllable optical element positioned to receive either of the input light beam or the redirected light beam and having an input terminal for receiving the control signal, the optical element being responsive to the control signal to produce a corresponding correction that offsets the predicted deviation The optical scanning system~~

~~of claim 2 wherein the predicted~~ deviation ~~distortion is a phase front distortion and wherein the corresponding distortion correctionis an offsetting phase front distortion.~~

Claim 10 has been amended as follows:

8. (Amended) An optical scanning system ~~of claim 9~~ comprising

an input port positioned to accept an input light beam;

at least one deflector aligned to receive the input light beam from the input port and oriented to redirect the received light beam through a selected periodic scan pattern having a plurality of scan lines, the deflector being of a type that produces a predicted deviation of the redirected light beam from a desired light beam at respective locations in the selected scan pattern;

an electrical control circuit operative to produce a control signal corresponding to the selected scan pattern;

a controllable optical element positioned to receive either of the input light beam or the redirected light beam and having an input terminal for receiving the control signal, the optical element being responsive to the control signal to produce a corresponding correction that offsets the predicted deviation within selected ones of the scan lines wherein the predicted deviation is a phase front distortion and wherein the corresponding distortion correction is an offsetting phase front distortion; and

wherein the controllable optical element is a deformable membrane.

Claim 13 has been amended as follows:

13. (Amended) The imaging apparatus of claim 12 wherein the wavefront corrector includes a microelectromechanical (MEMS) device.

Claim 16 has been amended as follows:

16. (Amended) A scanning system for scanning through a substantially raster pattern having a scanning period and a plurality of scan lines, comprising:

a light source that emits a beam of light along a beam path;

a scanning mirror positioned in the beam path, the scanning mirror pivoting through a predetermined angular range to redirect the beam of light through selected lines in the substantially raster pattern; and

an active optical element oriented to receive the beam of light and direct the received beam of light along the beam path to the scanning mirror, the optical element being operative to pre-distort the beam of light in a periodic manner corresponding to the orientation of the scanning mirror in the predetermined angular range.

Please amend claim 17 as follows:

17. (Amended) The scanning system of claim 16 wherein the active optical element includes a microelectromechanical (MEMS) device.

Claim 21 has been amended as follows:

21. (Amended) A scanning module, comprising:

a microelectromechanical (MEMS) scanning mirror that moves through a predetermined scan path at a selected scan rate having a scanning period; and

a MEMS membrane aligned to the MEMS scanning mirror, the membrane being deformable through a desired deformation range and having a response time

sufficiently fast to deform through the desired deformation range within the scanning period.

Claim 23 has been amended as follows:

23. (Amended) The scanning module of claim 21 wherein the MEMS membrane has a resonant frequency ~~has~~ having a period that is an integral multiple of the scanning period.

Claim 27 has been amended as follows:

27. (Twice Amended) A scanning apparatus, comprising:

a primary mirror that moves through a predetermined scan path at a selected scan rate having a scanning period; and

a resonant reflector aligned to the scanning mirror and being of a type that moves resonantly through a movement path at a resonant frequency, wherein the scan period is an integral multiple of the resonant frequency wherein the resonant reflector is a microelectromechanical (MEMS) membrane and wherein the movement path includes deformation of the membrane.

Claim 29 has been amended as follows:

29. (Amended) The apparatus of claim 28~~6~~ wherein the primary mirror is a microelectromechanical (MEMS) device.